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STIFF, C.T.

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LARGE-TREE DIAMETER INCREMENT MODELS FOR THE CENTRAL IDAHO VARIANT OF THE STAND PROGNOSIS MODEL

FINAL REPORT FOR COOPERATIVE AGREEMENT No.
22-C-3-INT-162 with
UNIVERSITY OF IDAHO
FS Contact: A. Stage
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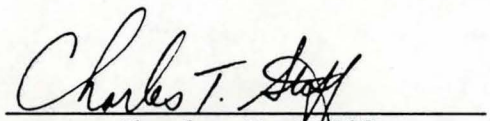
FINAL REPORT

Large-Tree Diameter Increment Models for the Central Idaho Variant of the Stand Prognosis Model

Submitted to:

United States Department of Agriculture
Forest Service
Intermountain Experiment Station



Charles T. Stiff
Principal Investigator

Department of Forest Resources
College of Forestry, Wildlife and Range Sciences
University of Idaho
Moscow, Idaho 83843

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Introduction

For more than a decade, forest managers in the Inland Northwest have relied upon Stand Prognosis Model (Wykoff and others, 1982) projections for scheduling harvests, updating inventories, and comparing alternative stand treatments. Prognosis, an individual tree distance-dependent stand projection model, provides users with future stand volumes across a wide variety of species types, site conditions, and stand structures.

All facets of predicted tree development in version 5.1 of Prognosis (Wykoff, 1986) are dependent in part on dbh or large-tree (dbh equal to or greater than 3 inches) dbh increment. The Inland Empire version is calibrated for eleven commercial species using National Forest data from northern Idaho, northeastern Washington, and western Montana. Data represent both unmanaged and managed stands from over 30 habitat types. Species-specific models for large-tree dbh and height increment, small-tree height increment, crown ratio, and mortality are based on initial tree dimensions and stand conditions along with site attributes.

Forest managers outside the geographic range of the Inland Empire version use the Prognosis Model for projecting their forests. Optional calibration procedures within Prognosis use samples of current increment to localize projections for variations in site not represented in model parameters. By using scalers and multipliers, users can sometimes obtain satisfactory results for their geographical area. However, multipliers only affect the magnitude of predicted increment and do not change the rate of increment across the predictor variables.

A better method for extending the Prognosis Model to new geographical regions is to recalibrate model coefficients using area-specific data. Johnson (1981) recalibrated Prognosis for the Beaverhead, Deerlodge, Gallatin, Helena, and Lewis & Clark National Forests in Montana. Similarly, regional Prognosis variants have been completed for south central Oregon and northeastern California (Johnson and others, 1986), and for central Idaho along with eastern Oregon and Washington (Horn, 1982; Stiff and others, 1982; Josephs, 1984).

This paper reports new large-tree diameter increment models for six major commercial species in central Idaho. Unlike previously reported models, the new models include the latest Boise National Forest inventory, central Idaho habitat types (Steele and others, 1981), and habitat types and elevations for the Salmon and Challis National Forests.

Data

Data Collection

The study area included the Boise, Challis, Payette, Salmon, and Sawtooth National Forests (Fig. 1). Type 1 stand examination data obtained from the USDA Forest Service Region 4 were collected in 1986, 1974, 1979, 1973, and 1969, respectively. Stands were sampled with a cluster of variable-radius plots with nested fixed-area regeneration plots. The radius (limiting distance) of the variable plot was determined by the

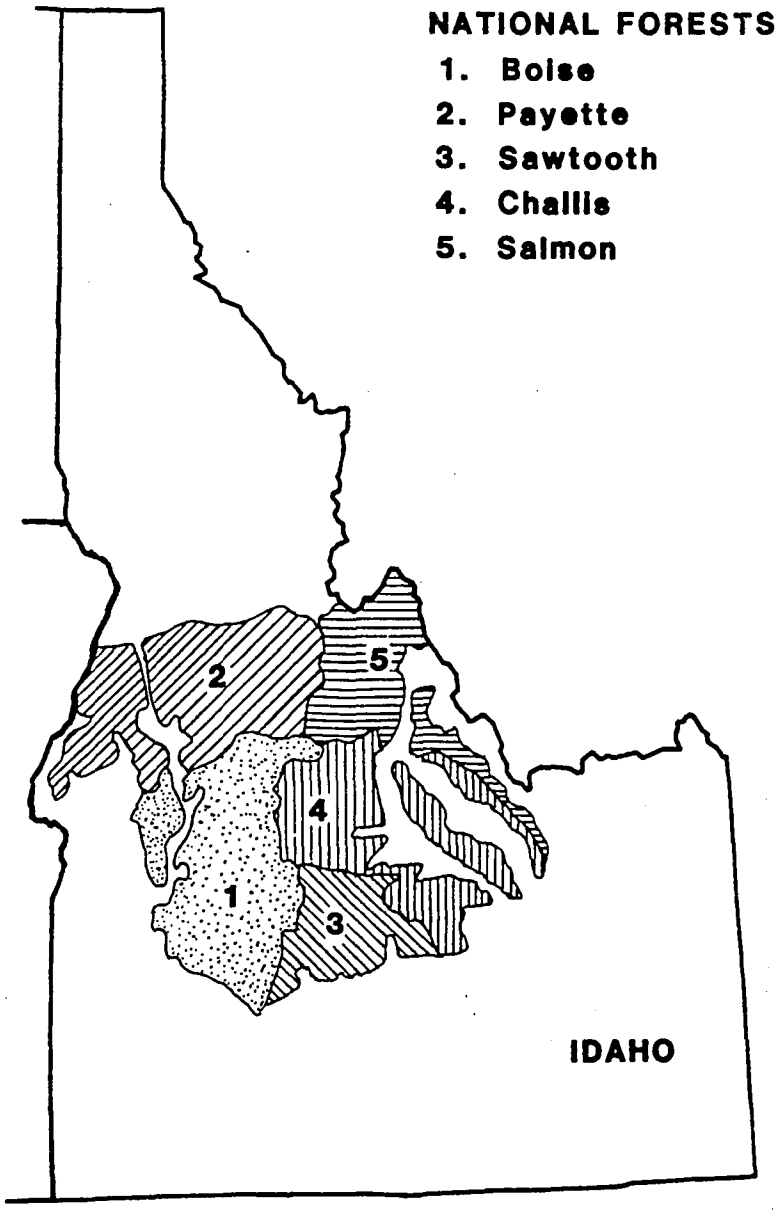

Figure 1. National Forests used for calibrating the large-tree diameter increment models in the central Idaho variant of the Stand Prognosis Model.

dbh of all live and dead trees 5-inches dbh and larger. Live trees at least 6-inches in height to 4.99-inches dbh were recorded on fixed plots. Most stands were sampled with 40 BAF variable plots with nested 1/300 acre fixed plots.

All data included site and individual tree information for plots within stands. Site information used for model development included stand slope (%), stand aspect (1=north, 2=north east, etc.), stand elevation (in 100's of feet), geographic location (i.e., National Forest), and stand habitat type (Steele and others, 1981). Individual tree information included species, dbh (diameter at breast height outside bark to the nearest 0.1 inch), live crown ratio (1=0-10%, 2=11-20%, etc.), past 10-year dbh increment (to the nearest 0.2 inch inside bark), and an estimate of when mortality occurred for dead trees. Increment data were gathered by boring a subsample of live trees with dbh equal to or greater than 3.0 inches. Table 1 lists tree species sampled on the central Idaho National Forests. Other species includes both coniferous and deciduous species such as whitebark pine, aspen, and cottonwood.

Table 1. Tree species in the central Idaho variant of the Stand Prognosis Model.

Common name	*Scientific name*	Species code	Numeric code
Douglas fir	*Pseudotsuga menziesii*	DF	3
Grand fir	*Abies grandis*	GF	4
Lodgepole pine	*Pinus contorta*	LP	7
Engelmann spruce	*Picea engelmanii*	ES	8
Subalpine fir	*Abies lasiocarpa*	AF	9
Ponderosa pine	*Pinus ponderosa*	PP	10
Other species[1]	-	-	11

[1]Includes other softwood and hardwood species

Backdating Procedures

Large-tree diameter increment models were calibrated using inventory data backdated to the beginning of the growth period. The dependent variable (LDDS10) was the natural logarithm of 10-year change in squared inside bark diameter. LDDS10 was backdated based on current dbh and past dbh increment as:

$$LDDS10 = \ln[\ (DBH_1 * BKRAT + DINC)^2 - (DBH_1 * BKRAT)^2\ ]$$

where, DBH_1 = dbh at the beginning of the growth measurement period
DINC = 10-year inside bark dbh increment
BKRAT = bark thickness factor (Wykoff and others, 1982)
ln = natural logarithm

and DBH_1 was given by:

$$DBH_1 = DBH_2 - (DINC/BKRAT)$$

where, DBH_2 = dbh at the end of the growth measurement period

Variables representing stand density (CCF) and individual tree relative competitive status (BAL) were also backdated to the beginning of the growth measurement period. The backdating technique was taken from calibration procedures within the Prognosis Model.

Trees which did not have measured dbh increments were backdated using species-specific growth ratios calculated for trees which had measured increments. If a species within the stand had no measured increments, the average basal area growth ratio for measured trees was used. Trees which had died during the growth measurement period were assigned the current dbh.

Site variables such as slope, aspect, elevation, habitat type, and geographic location were assumed to remain constant through time. In addition, individual tree crown ratio was assumed constant for the measurement period.

Only trees with measured 10-year increments were used to calibrate species-specific large-tree dbh increment models. Table 2 gives a summary of site and backdated tree and stand variables by species for the increment data. The number of observations by species and geographic location is given in Table 3. Douglas-fir was a stratified random sample taken from 18,500 observations based on National Forest, habitat type, and 2-inch dbh classes.

Table 3. Number of observations by species and location for the large-tree dbh increment models in central Idaho.

National Forest	Species							
	AF	DF	ES	GF	LP	PP	OT	Total
Boise	1539	1361	624	394	1080	1769	129	6896
Challis	1049	1276	445	0	1409	0	401	4580
Payette	2599	2206	1558	2738	2132	3958	499	15690
Salmon	410	1073	221	0	1522	278	191	3695
Sawtooth	330	770	86	0	661	26	184	2057
Total	5927	6686	2934	3132	6804	6031	1404	32918

Habitat Classes

Habitat types were grouped into habitat classes by species prior to fitting increment models. First, habitat types with fewer than 5% of the total observations were grouped by series. Second, all series with fewer than 5% of the total observations were pooled into a common class.

Table 2. Stand, site and tree summary by species for the large-tree dbh increment model in central Idaho.

Variable	Mean	Std. dev.	Minimum	Maximum
		Species = AF		
Dbh (in.)	11.7	6.0	3.0	43.2
Dbh inc. (in/10yrs)	0.83	0.55	0.1	5.6
Crown ratio (%/100)	0.61	0.18	0.05	0.95
Slope (%/100)	0.32	0.16	0.0	0.90
Elevation (100's ft)	71.7	7.8	42.0	116.0
BAL (ft^2/acre)	63.9	40.8	0.0	279.2
CCF (/acre)	122.7	42.2	1.7	362.6
		Species = DF		
Dbh (in.)	18.2	9.8	3.0	84.1
Dbh inc. (in/10yrs)	0.83	0.60	0.1	4.7
Crown ratio (%/100)	0.53	0.17	0.05	0.95
Slope (%/100)	0.44	0.17	0.0	0.92
Elevation (100's ft)	64.6	11.4	30.0	107.0
BAL (ft^2/acre)	45.7	37.3	0.0	252.6
CCF (/acre)	106.6	46.4	2.6	362.6
		Species = ES		
Dbh (in.)	18.1	8.8	3.0	61.0
Dbh inc. (in/10yrs)	0.91	0.60	0.1	4.3
Crown ratio (%/100)	0.57	0.17	0.05	0.95
Slope (%/100)	0.27	0.15	0.0	0.82
Elevation (100's ft)	68.2	10.0	42.0	96.0
BAL (ft^2/acre)	46.5	40.8	0.0	240.8
CCF (/acre)	121.5	39.3	8.6	267.4
		Species = GF		
Dbh (in.)	16.9	11.2	3.0	58.5
Dbh inc. (in/10 yrs)	1.48	0.81	0.1	6.0
Crown ratio (%/100)	0.51	0.18	0.05	0.95
Slope (%/100)	0.35	0.13	0.0	0.90
Elevation (100's ft)	54.8	6.1	36.0	70.0
BAL (ft^2/acre)	58.4	42.7	0.0	261.0
CCF (/acre)	114.2	50.1	9.9	280.8

Table 2 (continued)

	Mean	Std. Dev.	Min.	Max.
Species = LP				
Dbh (in.)	8.4	3.3	3.0	31.5
Dbh inc. (in/10yrs)	0.65	0.41	0.1	3.2
Crown Ratio (%/100)	0.31	0.17	0.05	0.95
Slope (%/100)	0.28	0.16	0.0	0.90
Elevation (100's ft)	70.8	8.0	42.0	116.0
BAL (ft^2/acre)	51.6	32.8	0.0	201.5
CCF (/acre)	111.6	36.6	1.7	251.0
Species = PP				
Dbh (in.)	22.8	10.9	3.1	77.6
Dbh inc. (in/10yrs)	0.95	0.66	0.1	5.8
Crown radio (%/100)	0.45	0.16	0.05	0.95
Slope (%/100)	0.42	0.16	0.0	0.85
Elevation (100's ft)	50.9	6.5	30.0	82.0
BAL (ft^2/acre)	31.3	28.2	0.0	184.6
CCF (/acre)	75.1	34.3	1.9	218.1
Species = OT				
Dbh (in.)	12.0	7.4	3.1	64.0
Dbh inc. (in/10yrs)	0.59	0.43	0.1	4.0
Crown ratio (%/100)	0.40	0.16	0.05	0.95
Slope (%/100)	0.38	0.18	0.0	0.90
Elevation (100's ft)	73.0	13.6	41.0	116.0
BAL (ft^2/acre)	50.1	35.8	0.0	226.7
CCF (/acre)	110.2	42.3	6.1	261.4

Table 4. Classification of habitat types within habitat classes by species for the large-tree dbh increment model in central Idaho.

Species Code	Habitat Class	No. of Obs.	Habitat types within Habitat Classes
AF	1	448	0249, 0299, 0401, 0517, 0519, 0616, 1102, 1104, 1107, 1113, 1117, 1119, 1124, 1129, 1138, 1145, 1148, 1151, 1153, 1154, 1199
	2	1129	0217
	3	441	0219
	4	263	0233
	5	911	0252
	6	377	0253
	7	736	0254
	8	359	0100, 0102, 0117, 0119, 0121, 0122, 0132, 0145, 0148, 0153
	9	1263	0200, 0202, 0205, 0207, 0214, 0215, 0221, 0222, 0229, 0230, 0232, 0234, 0243, 0245, 0246, 0247, 0251
DF	1	735	0117, 0119, 0121, 0122, 0132, 0138, 0145, 0148, 0151, 0153, 0154, 0401, 0517, 0519, 0616, 0804, 0824, 0842, 0848, 0849, 1100, 1104, 1107, 1113, 1199
	2	486	0102
	3	340	1102
	4	305	1117
	5	1010	1119
	6	883	1138
	7	319	1148
	8	1409	0200, 0202, 0205, 0207, 0215, 0217, 0219, 0221, 0222, 0229, 0232, 0233, 0234, 0243, 0245, 0246, 0247, 0251, 0252, 0253, 0254
	9	1199	1100, 1104, 1107, 1113, 1120, 1121, 1124, 1129, 1132, 1135, 1145, 1149, 1151, 1153, 1154
ES	1	287	0117, 0121, 0122, 0132, 0138, 0145, 0148, 0299, 0401, 0517, 0519, 0616, 1102, 1104, 1107, 1113, 1117, 1119, 1129, 1138, 1145, 1148, 1153, 1199
	2	159	0102
	3	286	0153
	4	145	0215
	5	114	0217
	6	116	0219
	7	244	0233
	8	323	0252
	9	253	0253
	10	418	0254
	11	589	0200, 0202, 0205, 0207, 0214, 0221, 0222, 0229, 0230, 0232, 0234, 0243, 0245, 0246, 0251

Table 4 (continued).

GF	1	226	0202, 0205, 0217, 0219, 0221, 0222, 0232, 0234, 0245, 0249, 0253, 0254, 1102, 1117, 1138, 1145, 1148
	2	1350	0102
	3	251	0121
	4	341	0145
	5	817	0153
	6	147	0100, 0119, 0122, 0132, 0138, 0148, 0154
LP	1	437	0249, 0299, 0401, 0517, 0519, 0524, 0616, 0842, 1199
	2	516	0217
	3	543	0219
	4	1219	0252
	5	305	0253
	6	1058	0254
	7	632	1119
	8	484	0100, 0102, 0117, 0119, 0121, 0122, 0145, 0151, 0153, 0154
	9	849	0200, 0202, 0205, 0207, 0214, 0215, 0221, 0222, 0229, 0230, 0232, 0233, 0234, 0243, 0245, 0246, 0247, 0251
	10	761	1100, 1102, 1104, 1107, 1113, 1117, 1121, 1124, 1129, 1132, 1135, 1138, 1145, 1148, 1149, 1151, 1153, 1154
PP	1	680	0200, 0202, 0204, 0207, 0215, 0217, 0219, 0221, 0232, 0234, 0245, 0252, 0253, 0254, 0804, 0824, 0838, 0842, 0868, 0849
	2	817	0102
	3	312	0145
	4	276	1119
	5	1585	1138
	6	712	1145
	7	650	1148
	8	351	0100, 0119, 0121, 0122, 0132, 0138, 0148, 0153, 0154
	9	648	1100, 1102, 1104, 1107, 1113, 1117, 1124, 1135, 1149, 1153, 1154
OT	1	235	0117, 0121, 0122, 0132, 0145, 0148, 0154, 0401, 0616, 0838, 1004, 1049, 1199
	2	100	0102
	3	112	0153
	4	129	0217
	5	91	0233
	6	164	0252
	7	100	0254
	8	204	0200, 0202, 0205, 0207, 0215, 0219, 0221, 0222, 0229, 0230, 0232, 0234, 0243, 0245, 0251, 0253
	9	269	1100, 1102, 1104, 1107, 1113, 1117, 1119, 1120, 1124, 1129, 1135, 1138, 1145, 1148, 1149, 1153, 1154

Grouping habitat types resulted in 6 to 11 classes per species (Table 4), thereby creating adequate numbers of observations by class for estimating habitat-specific intercept and slope coefficients.

Maximum Basal Area

Species-specific mortality can be predicted with the central Idaho variant by using the existing mortality models in the Inland Empire version or recoding with Joseph's (1984) central Idaho mortality functions. Mortality estimates for both models are based on the assumption that there is a maximum basal area that a site can sustain and that this maximum varies by site quality. Appendix Table A-1 contains observed stand BAMAX values for habitat types in central Idaho. In most cases the values are lower than those used for similar habitat types in northern Idaho.

Diameter Increment Model

Model Development

The following linear model was used for developing large-tree diameter increment models for the central Idaho variant:

$$\begin{aligned} LDDS10 = \; & b_o + b_1*HAB_i + b_2*LOC_i + b_3*LDBH \\ & + b_4*DBH2 + b_5*DBH + b_6*CR + b_7*CR2 + b_8*SLOP \\ & + b_9*SLSQ + b_{10}*EL + b_{11}*EL2 + b_{12}*CASP \\ & + b_{13}*SASP + b_{14}*BAL/100 + b_{15}*BALDBH/100 \\ & + b_{16}*CCF_i/100 \end{aligned}$$

where,

LDDS10	=	natural log of 10-year change in squared dbh
HAB_i	=	habitat dependent intercept shifter
LOC_i	=	location dependent intercept shifter
DBH	=	diameter outside bark at 4.5 feet (inches)
LDBH	=	natural log of dbh
DBH2	=	dbh squared
CR	=	ratio of crown length to total tree height
CR2	=	CR squared
SLOP	=	stand slope (%/100)
SLSQ	=	SLOP squared
EL	=	stand elevation (in 1000's of feet)
EL2	=	EL squared
ASP	=	stand aspect (in degrees)
CASP	=	SLOP*COS(ASP)
SASP	=	SLOP*SIN(ASP)
BAL	=	basal area in larger trees (ft^2/acre)
BALDBH	=	BAL/ln(DBH+1)
CCF_i	=	habitat dependent crown competition factor
b_i	=	estimated least square coefficients

Squared terms for DBH, CR, SLOP, and EL were centered (e.g., $[DBH - \bar{DBH}]^2$) to remove ill-conditioning in the regressions. The model formulation is thus the same as the Inland Empire version except for the inclusion of a linear DBH term and omission of the DBH^2*LOC interaction term.

Species-specific models were developed using the following procedure:

1. Dummy variables representing habitat class and geographic location (i.e., National Forest) were included in a regression along with all continuous predictor variables and their interactions (i.e., DBH^2*LOC and CCF*HAB). Dummy variables with coefficients not significantly different from 0 (alpha=0.10) were included in the overall intercept b_0. Coefficients of the remaining dummy variables were then compared to each other using a simple t-test. Because of unequal class sizes, least square means were used for the comparisons instead of class means. Classes not significantly different (alpha=0.10) were combined.

2. The whole model with significant dummy class variables but excluding interaction terms was refit to the data. Continuous predictor variables with a level attained greater than 0.10 were removed from the model.

   Inherent correlations within the data resulted in positive DBH^2 terms for subalpine fir, Engelmann spruce, lodgepole pine, and other species. DBH^2 was estimated with a negative sign only after removing both BAL and BALDBH. Correlation problems could have resulted from less harvesting at higher elevations in stands containing those species (i.e., greater inherent correlations between tree size, stand density, and stand elevation).

3. An interaction between geographic location and DBH^2 was then introduced into the model including significant continuous and dummy variables. The interaction term was insignificant for all species, and therefore, only the DBH^2 term was included in the final model. The DBH^2 term for subalpine fir was estimated for the Payette National Forest and the final model was estimated with b_4*DBH^2 subtracted from LDDS10.

4. Next, the interaction between habitat class and CCF was introduced into the model having both significant continuous and dummy variables. The interaction allows carrying capacity to vary with site quality. The testing and grouping described in step 1 was applied to these interaction variables.

5. During this step all significant continuous, dummy, and interaction variables were fixed in the model. Continuous variables previously removed from the model were then re-examined using stepwise regression. Significant variables having the proper sign and not adversely affecting estimated coefficients for other variables were included in the final model.

6. Finally, mean residuals and plots of residuals versus the predicted value and predictor variables were examined. Residuals did not

indicate that additional variables or transformations would improve performance for any species-specific model.

Final Diameter Increment Model

Coefficients by species and fit statistics for the final large-tree dbh increment model in central Idaho are given in Tables 5 and 6, respectively.

Table 6. Fit statistics by species for the large-tree dbh increment models in central Idaho.

Statistic	Species						
	AF	DF	ES	GF	LP	PP	OT
n	5927	6686	2934	3132	6804	6031	1404
R^2	0.56	0.56	0.59	0.70	0.41	0.41	0.49
RMSE	0.6022	0.6383	0.5971	0.5299	0.5606	0.5711	0.6348

Index values by species for habitat class, location, and habitat-dependent CCF are given in Tables 7-9, respectively.

Model Behavior

Large-tree diameter increment predictions for all species are compared using the Inland Empire and central Idaho variants of the Stand Prognosis Model (Figs. 2-8). Curves shown are for trees in the 50th percentile of the basal area distribution (i.e., intermediate or codominant crown class) on a grand fir/Clintonia habitat type at 6,000 feet elevation with north-facing 20% slopes in the Payette and Nez Perce National Forests. In general, the central Idaho variant shows less growth at smaller diameters for combinations of crown ratio and CCF.

Table 5. Coefficients by species for the large-tree dbh increment model in central Idaho.

Variables (Classes)		Species AF	DF	ES	GF	LP	PP	OT
Intercept		1.06555	0.85066	1.22765	0.93015	0.93168	1.93111	1.00366
Habitat Type Class Constants	1	0.13005	0.19152	-0.21182	0.0	-0.07657	0.07723	0.17800
	2	0.15960	0.15311	0.0		-0.25074	0.12764	0.0
	3	0.0	0.0			-0.13226	-0.10239	
	4					0.09945	0.0	
						0.0		
Location Class Constants	1	-0.11430	-0.40318	-0.29874	0.13973	0.08070	-0.22071	-0.25517
	2	-0.29120	0.14932	0.0	0.0	0.0	0.0	0.0
	3	0.33369	0.0					
	4	0.14065						
	5	0.0						
LDBH		0.98874	0.70328	1.01554	0.83829	0.82709	0.30464	0.89944
DBH2		-0.000213	-0.000111	-0.000145	-0.000328	-0.000196	-0.000154	-0.000565
DBH		0.00498	0.00405	0.00523	0.01112	0.00331	0.00700	0.01352
CR		0.55715	1.66950	1.06903	1.94340	1.72304	2.30755	0.96206
CR2		0.41516	-0.63366	0.0	-0.57408	-0.54058	-0.76994	0.0
SLOP		0.0	-0.17767	0.41473	-0.21973	-0.08422	-0.53990	-0.53513
SLSQ		0.0	-0.53235	-0.78152	0.0	0.0	0.0	0.0
EL		-0.13327	0.08111	-0.15459	-0.02971	-0.08480	-0.02576	-0.12064
EL2		0.0	-0.01101	0.0	0.0	0.0	0.0	0.0
CASP		-0.32424	-0.14205	-0.14186	-0.13855	-0.20063	0.03776	-0.16893
SASP		-0.13413	0.10755	-0.07575	-0.10871	0.11388	0.13899	0.06020
BAL/100		0.0	-0.23500	0.0	0.38710	0.0	1.00846	0.0
BALDBH		0.0	0.0	0.0	-1.45235	0.0	-3.56147	0.0
CCF/100 Habitat Type Class	1	-0.18559	-0.19003	-0.31217	-0.08997	-0.23923	-0.04655	-0.15160
	2	-0.43873	-0.49735	-0.38332	-0.20858	-0.39425	-0.49039	0.0
	3	0.0	-0.24309	0.0	0.0	0.0	0.0	
	4		0.0					

Table 7. Index by species and habitat class for the large-tree dbh increment model in central Idaho.

Habitat Class	Species						
	AF	DF	ES	GF	LP	PP	OT
1	3	3	2	1	5	4	2
2	1	1	2	1	1	4	1
3	1	3	2	1	5	1	2
4	2	3	1	1	2	4	1
5	3	2	2	1	5	4	2
6	3	3	2	1	5	2	2
7	2	3	2	-	3	4	2
8	1	3	1	-	4	3	2
9	3	3	2	-	2	4	1
10	-	-	1	-	5	-	-
11	-	-	2	-	-	-	-

Table 8. Index by species and location for the large-tree dbh increment model in central Idaho.

National Forest	Species						
	AF	DF	ES	GF	LP	PP	OT
Boise	1	2	2	1	2	1	2
Challis	3	1	1	2	2	2	1
Payette	5	3	2	2	2	2	2
Salmon	2	1	2	2	2	2	2
Sawtooth	4	3	2	2	1	2	1

Table 9. Index by species and habitat-dependent CCF for the large-tree dbh increment model in central Idaho.

Habitat Class	Species						
	AF	DF	ES	GF	LP	PP	OT
1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1
3	1	1	1	2	2	1	1
4	2	1	1	1	1	1	1
5	1	2	1	1	2	1	1
6	1	1	1	1	2	2	1
7	2	1	2	-	2	1	1
8	1	3	1	-	1	1	1
9	1	3	1	-	1	1	1
10	-	-	1	-	2	-	-
11	-	-	2	-	-	-	-

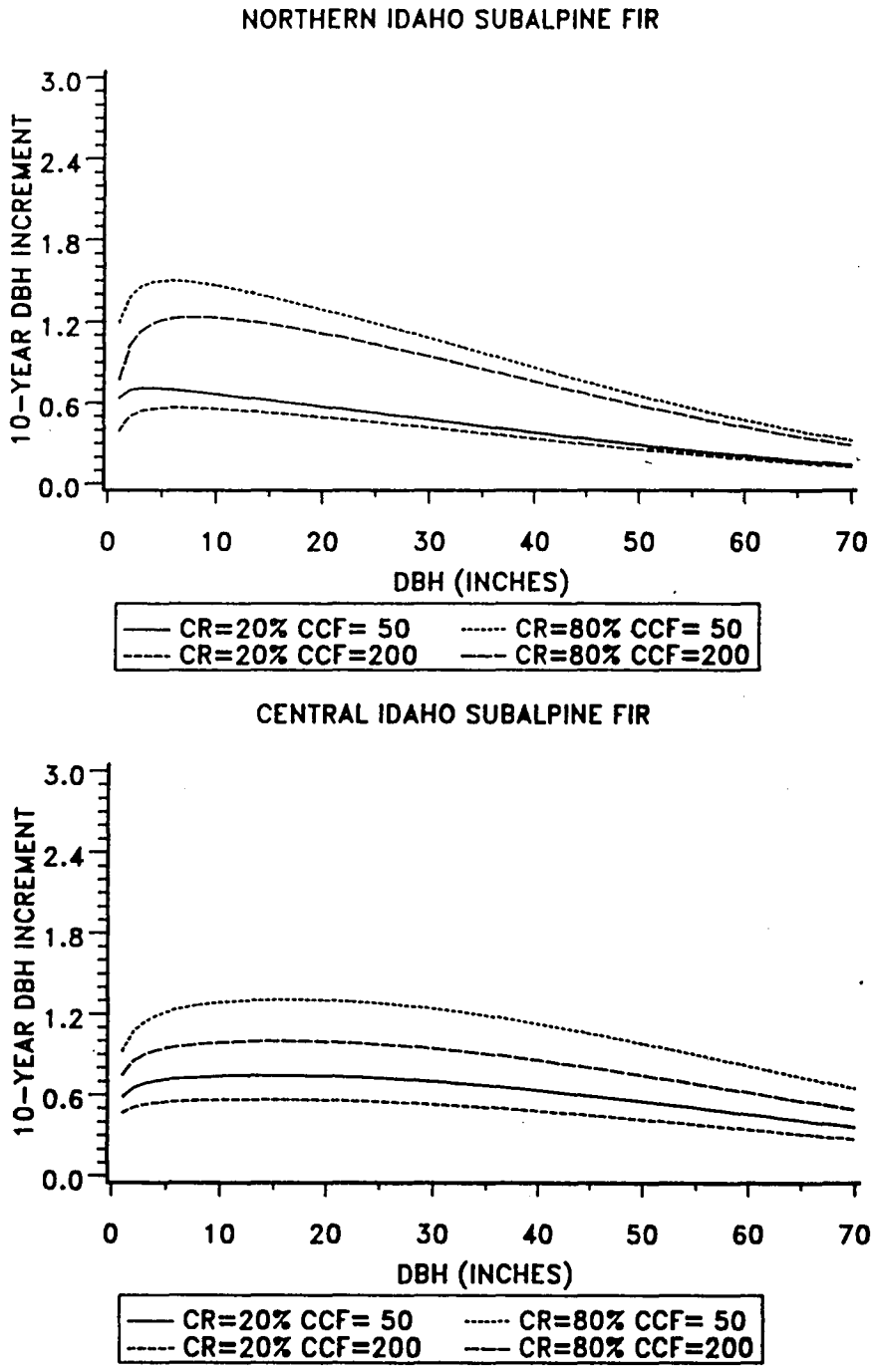

Figure 2. Large-tree diameter increment predictions for subalpine fir using the northern and central Idaho variants of the Stand Prognosis Model. Curves shown are for trees in the 50 percentile of the basal area distribution on a grand fir/Clintonia habitat type at 6,000 ft elevation with north-facing 20% slopes in the Payette and Nez Perce National Forests, respectively.

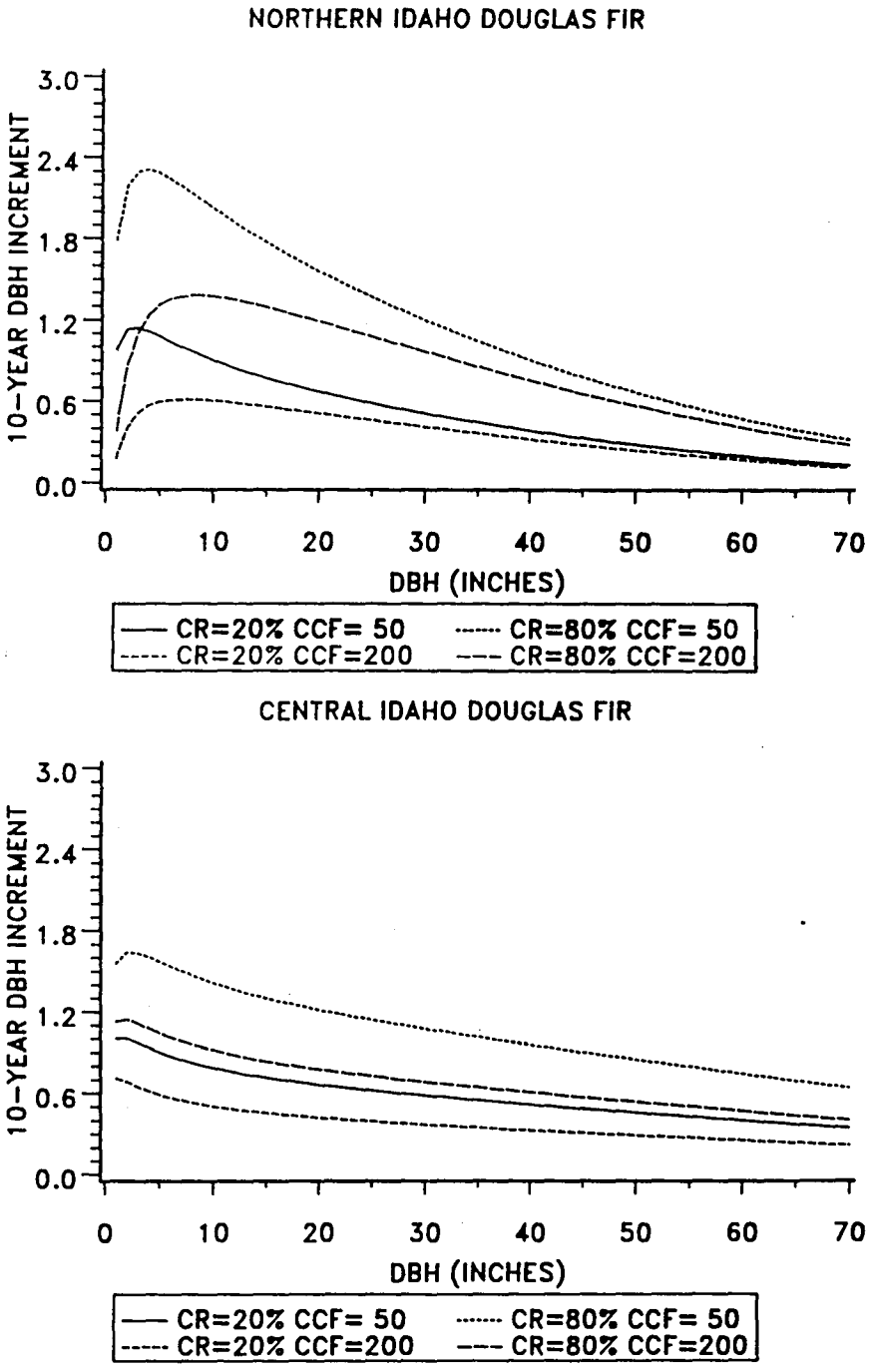

Figure 3. Large-tree diameter increment predictions for Douglas-fir using the northern and central Idaho variants of the Stand Prognosis Model. Curves shown are for trees in the 50 percentile of the basal area distribution on a grand fir/Clintonia habitat type at 6,000 ft elevation with north-facing 20% slopes in the Payette and Nez Perce National Forests, respectively.

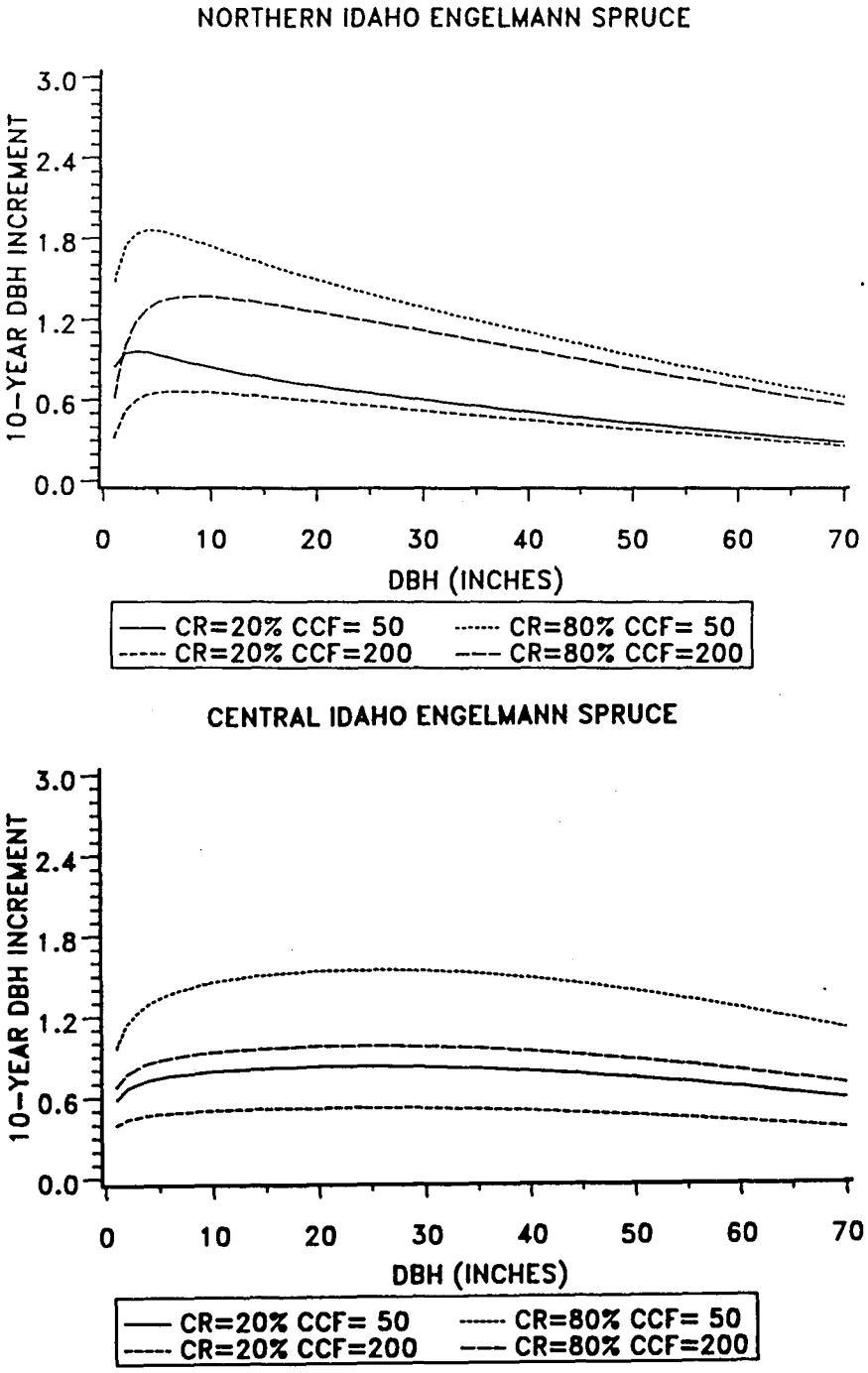

Figure 4. Large-tree diameter increment predictions for Engelmann spruce using the northern and central Idaho variants of the Stand Prognosis Model. Curves shown are for trees in the 50 percentile of the basal area distribution on a grand fir/Clintonia habitat type at 6,000 ft elevation with north-facing 20% slopes in the Payette and Nez Perce National Forests, respectively.

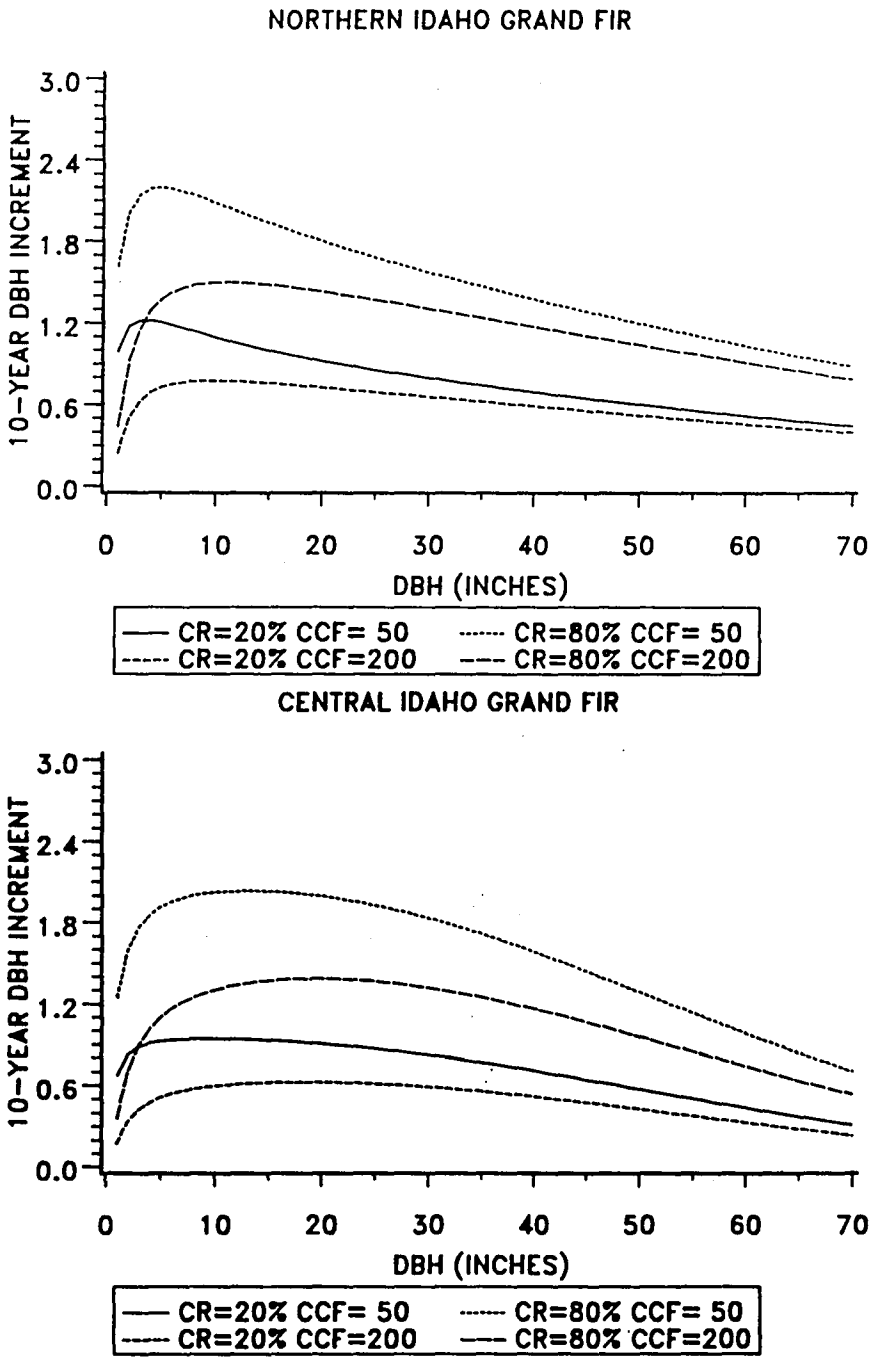

Figure 5. Large-tree diameter increment predictions for grand fir using the northern and central Idaho variants of the Stand Prognosis Model. Curves shown are for trees in the 50 percentile of the basal area distribution on a grand fir/Clintonia habitat type at 6,000 ft elevation with north-facing 20% slopes in the Payette and Nez Perce National Forests, respectively.

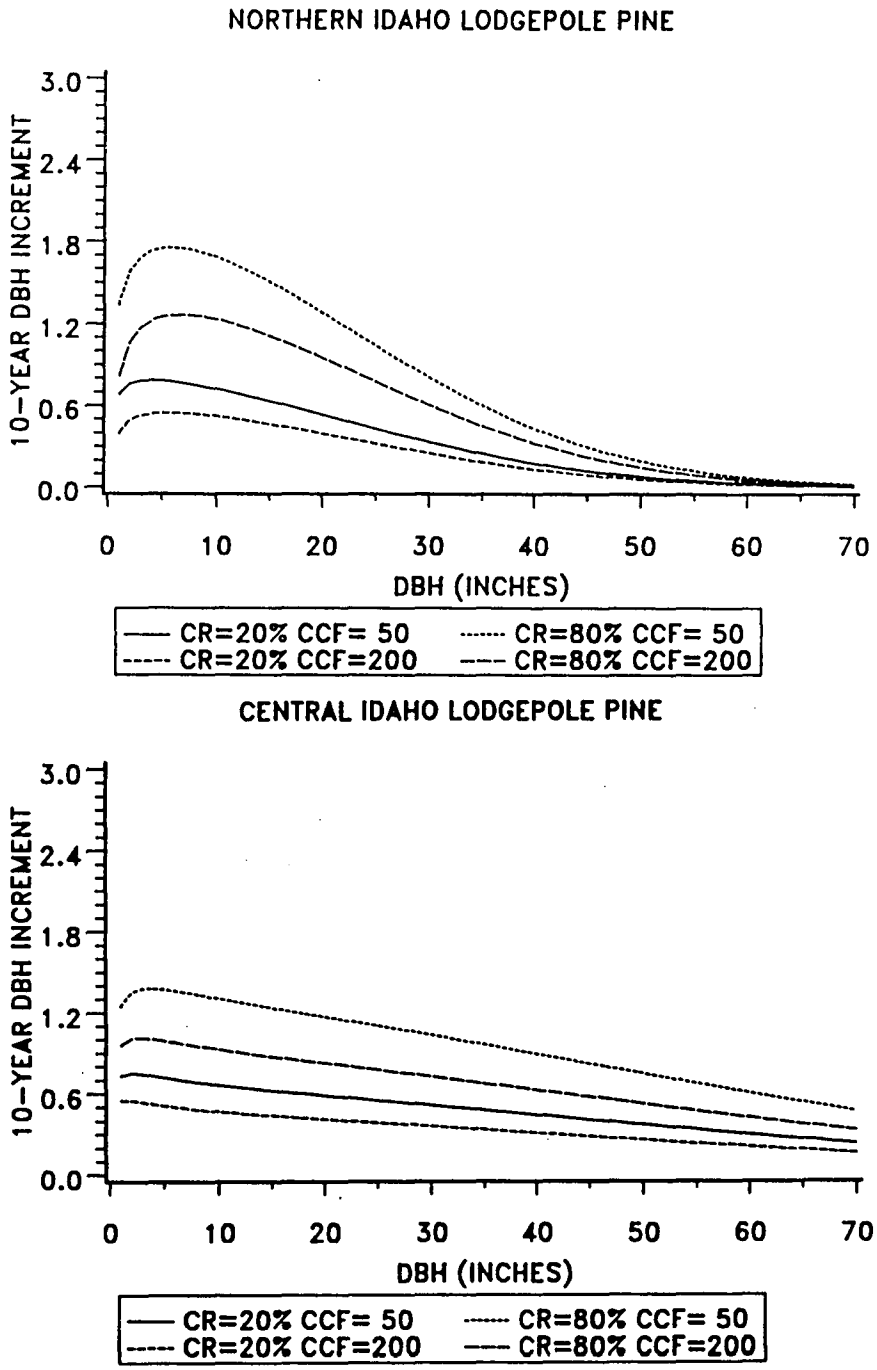

Figure 6. Large-tree diameter increment predictions for lodgepole pine using the northern and central Idaho variants of the Stand Prognosis Model. Curves shown are for trees in the 50 percentile of the basal area distribution on a grand fir/Clintonia habitat type at 6,000 ft elevation with north-facing 20% slopes in the Payette and Nez Perce National Forests, respectively.

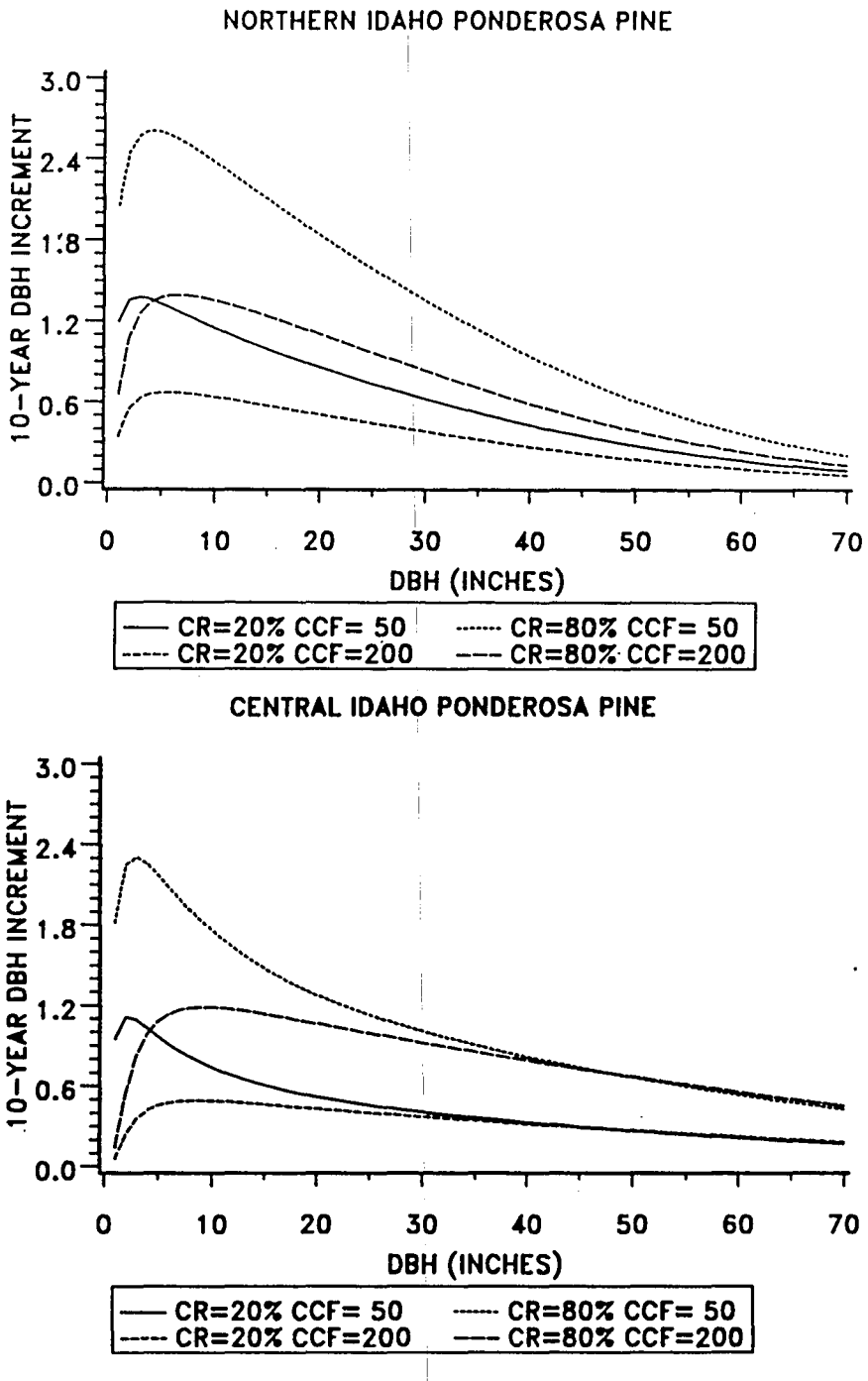

Figure 7. Large-tree diameter increment predictions for ponderosa pine using the northern and central Idaho variants of the Stand Prognosis Model. Curves shown are for trees in the 50 percentile of the basal area distribution on a grand fir/Clintonia habitat type at 6,000 ft elevation with north-facing 20% slopes in the Payette and Nez Perce National Forests, respectively.

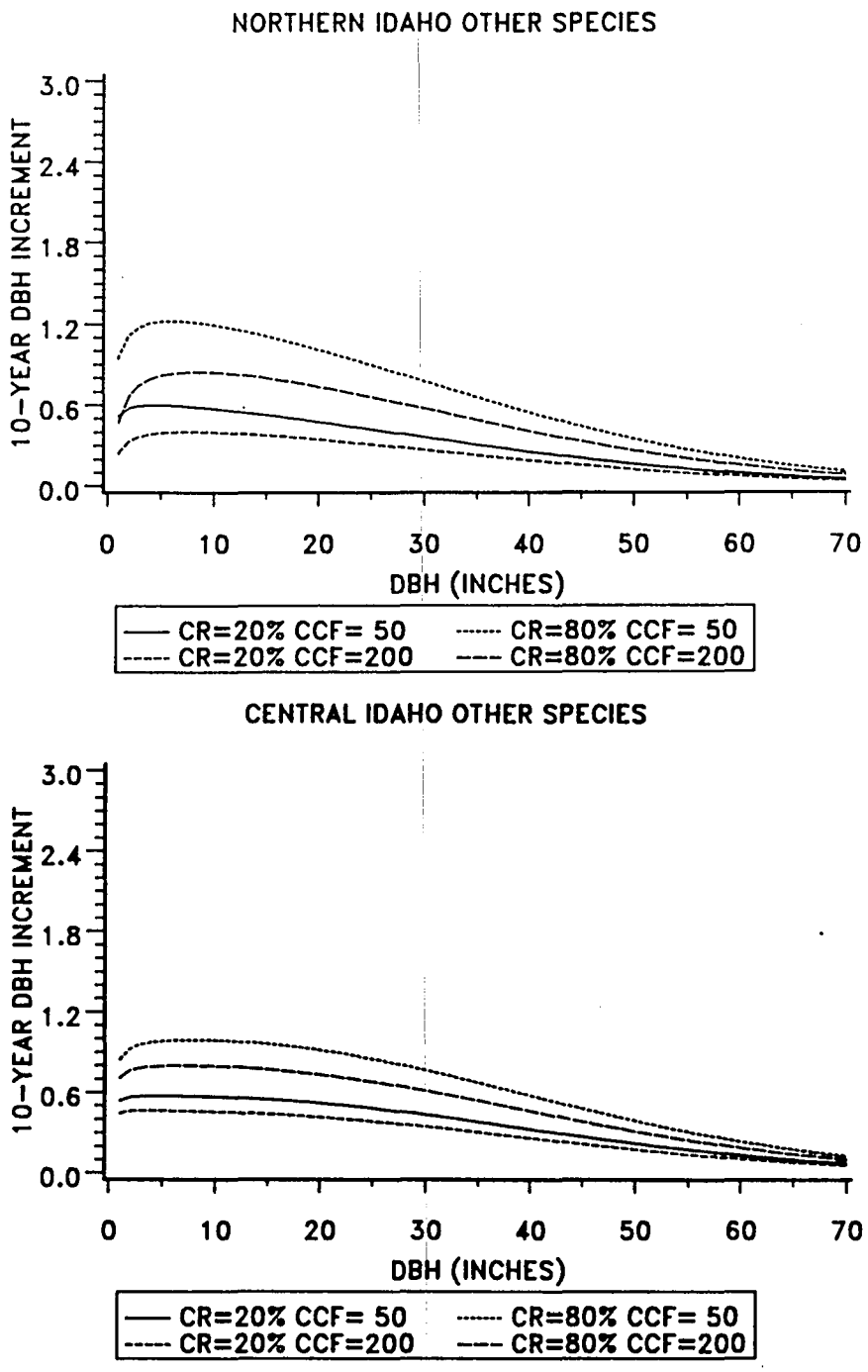

Figure 8. Large-tree diameter increment predictions for other species using the northern and central Idaho variants of the Stand Prognosis Model. Curves shown are for trees in the 50 percentile of the basal area distribution on a grand fir/Clintonia habitat type at 6,000 ft elevation with north-facing 20% slopes in the Payette and Nez Perce National Forests, respectively.

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Appendix

Table A-1. Observed maximum basal area (BAMAX) values used to adjust mortality rates in the central Idaho variant of the Stand Prognosis Model.

Central Idaho Habitat Codes	BAMAX	Central Idaho Habitat Codes	BAMAX
0102	276	0517	124
0117	127	0519	105
0119	121	0524	52
0121	186		
0122	164	0616	222
0132	174		
0138	57	0804	60
0145	200	0824	86
0148	118	0838	234
0151	153	0842	73
0153	211	0848	46
0154	140	0849	145
0200	166	1004	43
0202	189	1049	147
0204	130		
0205	244	1100	75
0207	192	1102	173
0214	218	1104	172
0215	255	1107	238
0217	199	1113	195
0219	296	1117	215
0221	161	1119	178
0222	151	1120	61
0229	183	1121	70
0230	133	1124	145
0232	83	1129	246
0233	174	1132	109
0234	213	1135	104
0243	160	1138	205
0245	172	1145	148
0246	155	1148	200
0249	138	1149	142
0251	143	1151	107
0252	215	1153	154
0253	227	1154	179
0254	207	1199	129
0299	127		
		9919	114
0401	100	9934	106